SYSTEM INTERCONNECTIONS

Memorandum of

ONTARIO HYDRO

to the

Royal Commission

on Electric Power Planning

with respect to the

Public Information Hearings

June, 1976

Line Number

I N D E X

13.1 Introduction

A transmission line which directly connects adjacent electric systems is called an interconnection.

For many years Ontario Hydro has been interconnected with the Great Lakes Power Corporation in the Sault Ste. Marie area of Ontario, Hydro-Quebec in Quebec, Manitoba Hydro in Manitoba, the Detroit Edison Company in Michigan and the Niagara Mohawk Power Corporation and the Power Authority of the State of New York (PASNY) in New York. Most of these interconnections form part of the bulk power networks of the interconnected utilities, and power may flow in either direction from moment to moment. The networks of Ontario Hydro, Manitoba Hydro, Great Lakes Power, Hydro-Quebec's Abitibi System, Detroit Edison, Niagara Mohawk, and PASNY are connected in this way and form part of a large power grid. This power grid extends over most of the Central and Eastern United States and the Canadian provinces of Saskatchewan, Manitoba, Ontario, New Brunswick and Nova Scotia. Because of stability considerations, the main part of the Hydro-Quebec system cannot operate in parallel with this large power grid. However, portions of Hydro-Quebec's system can be isolated and connected to the Ontario Hydro system. This enables deliveries of power from Quebec to Ontario. A similar procedure can be adopted to enable deliveries of power from Ontario to Quebec.

13.2 Interconnected Utility Organizations

Following the major power failure in the northeastern United States and Ontario on November 9, 1965, Ontario Hydro and electric utilities in New York and New England began a re-examination of the whole philosophy of interconnections and of the existing mechanisms for co-ordinated planning and operation. It was determined that while the interconnected network had provided a high level of reliability to the customer, it should be enhanced by greater co-ordination in the planning of future power systems, and in day to day system operation.

On January 19, 1966, executives representing electric utilities in New York, New England and Ontario signed an agreement establishing the Northeast Power Co-ordinating Council (NPCC), the first such organization in North America. The purpose of the Council is "to promote maximum reliability and efficiency of electric service in the interconnected systems of the signatory parties by extending the co-ordination of their system

planning and operating procedures". Today, the 21 NPCC member systems supply 98% of electric requirements in New England, New York, Ontario and New Brunswick.

Similar re-examinations took place throughout the world and eight other councils were formed in North America. In 1968 the National Electric Reliability Council (NERC) was formed to augment the reliability and adequacy of bulk power supply in the electric utility systems of North America. This Council consists of the nine regional reliability councils, including NPCC, and encompasses almost all of the power systems of the United States and the Canadian systems in Ontario, British Columbia, Manitoba and New Brunswick. Figure 13-1 shows a map of the 9 regional councils.

13.3 Operation of an Interconnected System

Interconnected power systems are generally subject to some type of regulatory approval. Operating agreements signed by the utilities involved provide the vehicle by which mutually acceptable standards, types or classes of transactions and billing rates are established. These agreements are limited in their scope to the immediately adjacent utilities or systems through which all interchanges with systems beyond must be transacted. This is essential as a means of protecting each system's right to use its transmission capability for its own purposes.

Communications between adjacent interconnected systems are normally made by dedicated voice circuits which connect the system control centres. Other equipment such as telecopier and teletype facilities is also used to broadcast general information and routine data over large geographic areas encompassing many systems.

Interconnected systems are operated, insofar as practical, in accordance with the same criteria for which they are designed. However, just as one part of an individual system should not be allowed to cause collapse of the entire system, so no system should be allowed to cause the collapse of the interconnected group of systems.

Each system in an interconnection operates its various elements within limits which are designed to prevent cascading i.e. trouble on one system spreading to others. Weaknesses which develop on a system due to scheduled or forced outages of components are made

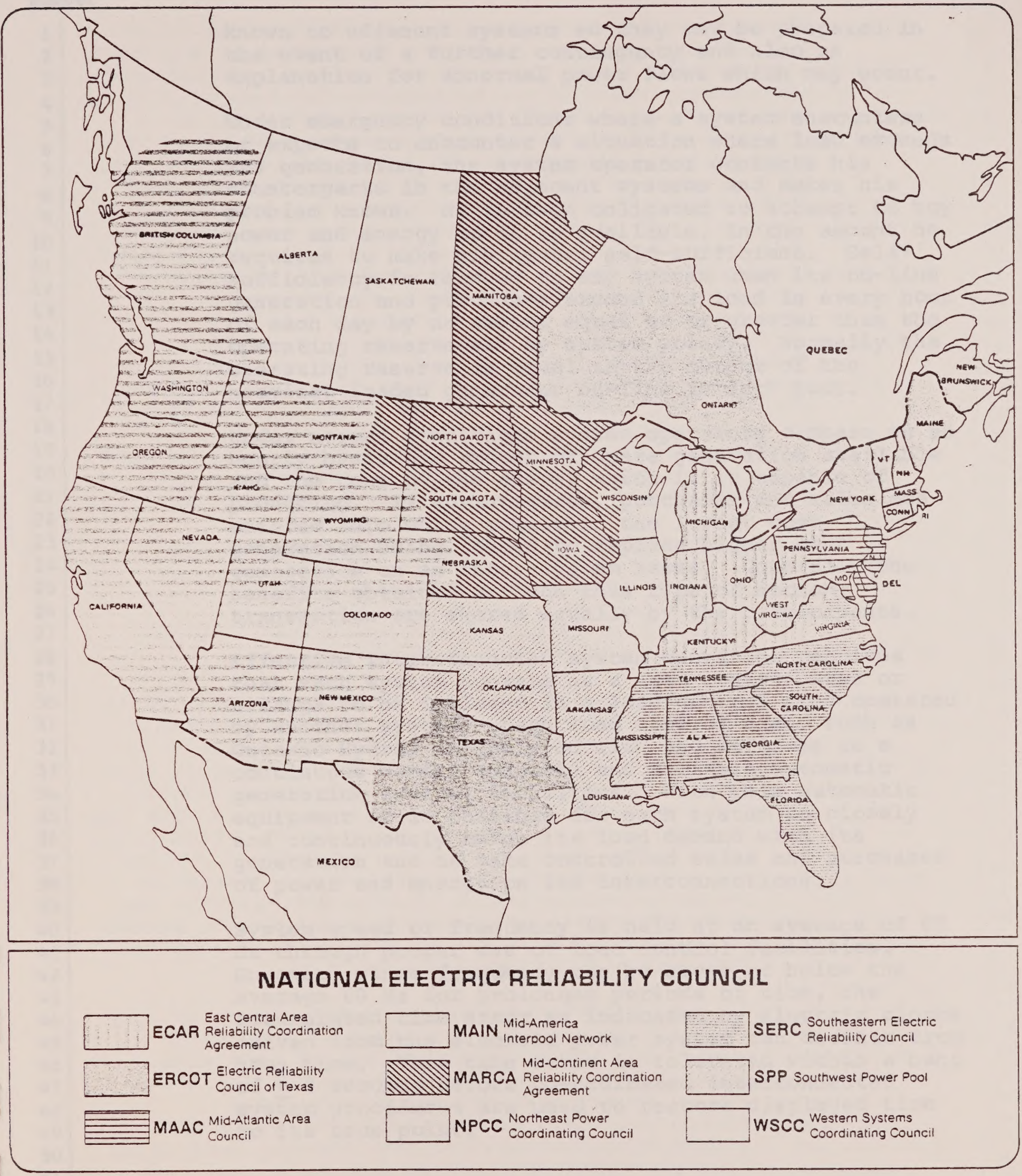

BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
QUEBEC
NEW BRUNSWICK
ONTARIO
MAINE
WASHINGTON
MONTANA
NORTH DAKOTA
OREGON
MINNESOTA
VT
NH
SOUTH DAKOTA
WISCONSIN
NEW YORK
MASS
CONN
RI
WYOMING
MICHIGAN
NEVADA
PENNSYLVANIA
IOWA
NEBRASKA
UTAH
ILLINOIS
INDIANA
OHIO
MD
DEL
CALIFORNIA
COLORADO
WEST VIRGINIA
KANSAS
MISSOURI
VIRGINIA
KENTUCKY
NORTH CAROLINA
TENNESSEE
OKLAHOMA
ARIZONA
NEW MEXICO
ARKANSAS
SOUTH CAROLINA
TEXAS
MISSISSIPPI
ALA
GEORGIA
LOUISIANA
FLORIDA
MEXICO
NATIONAL ELECTRIC RELIABILITY COUNCIL
ECAR East Central Area Reliability Coordination Agreement
MAIN Mid-America Interpool Network
SERC Southeastern Electric Reliability Council
ERCOT Electric Reliability Council of Texas
MARCA Mid-Continent Area Reliability Coordination Agreement
SPP Southwest Power Pool
MAAC Mid-Atlantic Area Council
NPCC Northeast Power Coordinating Council
WSCC Western Systems Coordinating Council

FIGURE 13-1

known to adjacent systems so they may be prepared in the event of a further contingency and also as explanation for abnormal power flows which may occur.

Under emergency conditions where a system encounters or expects to encounter a situation where load exceeds its generation, the system operator contacts his counterparts in the adjacent systems and makes his problem known. He is then obligated to attempt to buy power and energy if it is available, in the amount he requires to make his system self-sufficient. Self-sufficiency is reached on any system when its on-line generation and purchases exceed its load in every hour of each day by an amount equal to or greater than the operating reserve set by system policy. Normally the operating reserve is equal to the output of the heaviest loaded generator on-line in each hour.

Under normal conditions system operators compare on an hourly basis the amount of spare generation available and the cost of the energy which it is capable of producing. If advantageous, purchases and sales are entered into which result in the lowest cost generation being loaded to replace higher cost generation on an inter-system basis. Generally the benefits obtained through this type of economy transaction are shared equally by the participants.

Effective interconnected system operation requires that each system operate as a load control area or arrange to be included in a load control area operated by another system. Each load control area, such as Ontario Hydro, is equipped with and utilizes on a continuous basis, accurate and reliable automatic generation control facilities. With this automatic equipment it is possible for each system to closely and continuously match its load demand with its generation and to make controlled sales and purchases of power and energy on its interconnections.

System speed or frequency is held at an average of 60 Hz through proper use of load control facilities. However, since frequency can be above or below the average 60 Hz for prolonged periods of time, the accumulated time error as indicated by electric clocks driven from the electric power system can deviate from true time. This time error is tolerated within a band of ± 3 seconds before co-ordinated interconnected system procedures are used to restore displayed time to its true point.

The system frequency is common to all systems which are interconnected. An action or problem on any one system which tends to mismatch its load and generation immediately affects all systems in the form of high or low frequency. Should a system be deficient in generation, then low frequency results and power is automatically transferred to it by all other systems. If a surplus of loaded generation should occur on a system then all others react to the resulting high frequency and assist in absorbing the surplus power. This uncontrolled flow of power is called inadvertent energy. Complex accounting and payback procedures have been developed to keep the accumulated inadvertent energy at low levels.

Operation of an interconnected system automatically assists in overcoming short term operating problems. However, each member system has a responsibility not to take undue advantage of the automatic interconnection capability. In an emergency, it must either correct the problem on its system or make arrangements to purchase adequate generating capacity.

13.4 Advantages and Disadvantages of Interconnections

A. Advantages

(a) Increase in System Generation Reliability or Reduction in Reserve Generation.

As noted in the memorandum on Reliability, it is impossible to design, construct, and operate a generating system to be completely reliable. There is always some chance, however small, that the generating system cannot completely supply the load. This chance depends primarily upon the planned level of generation reserves, whether the actual load is substantially greater or smaller than the forecast load, whether the generation in an operating condition is more or less than the forecast amount, whether the transmission system is less than planned, and whether fuel supplies and stream flows are adequate.

If two systems are interconnected, there is some chance that when one is unable to completely supply its load, the other may, at that time, have surplus generation available which it can use to supply power to the first. This assistance could enable the first system to reduce or eliminate the load interruptions which it would otherwise have to impose on its

customers. At other times, the situation might reverse, with the second system receiving assistance from the first. There will also be occasions in which both systems are unable to supply their own loads at the same time. In such cases, neither system would be able to offer assistance to the other.

Two possibilities arise by virtue of an interconnection:

- Each of the systems can achieve an increase in reliability.
- One or both systems can deliberately reduce its own reserve generating capacity and depend upon the other for assistance to maintain the same reliability.

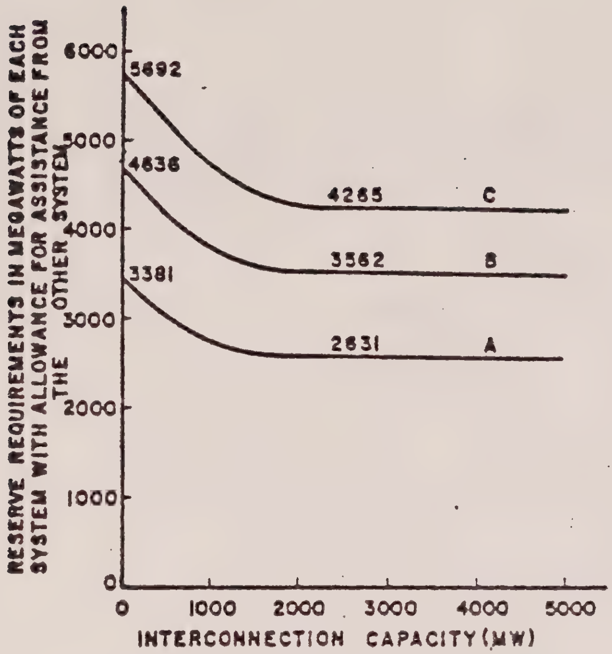
Increase in Reliability

Figure 13-2 illustrates the possibility of the improvement in reliability which can result from interconnecting two identical systems with neither system reducing its installed generation. The data in the Figure are obtained by application of Loss of Load Probability (LOLP) programs similar to those described in the memorandum on Reliability. The Figure shows the change in reliability as the interconnection capacity between the two systems is increased. It assumes that the generation and load levels in each of the systems remain the same when the interconnection is made. Three cases are shown, corresponding to three alternative reliability levels in each system when they are not interconnected.

As illustrated, interconnecting systems reduces the Loss-Of-Load probability and therefore improves the reliability of each system. The relative improvement is less if the reliability with zero interconnection capacity is low.

Reduction in Reserve Generating Capacity

Figure 13-3 illustrates the possible reduction in reserve requirements resulting from the same interconnection arrangement, i.e., with two identical systems. In this case, instead of using the interconnection to improve reliability, it is used to maintain a constant reliability



Based on Ontario Hydro East System generation proposed for December 1982 interconnected with identical system. Each system reduces its reserve after interconnection to maintain LOLP at the following level:

Case (a)	100/2400
Case (b)	10/2400
Case (c)	1/2400

ILLUSTRATION OF THE POSSIBLE REDUCTION IN RESERVE REQUIREMENTS AS A FUNCTION OF THE INTERCONNECTION CAPACITY

FIGURE 13-3

with lower generation reserves on each system. Three cases are shown corresponding to three levels of reliability. From Figure 13-3 the following data can be derived:

For Each System

		Required Reserve Level				Possible Reductions in Required Reserve	
		No Intercon-nection		With Intercon-nection			
Case	LOLP	MW	% of Load	MW	% of Load	MW	% of Load
(a)	100/2400	3381	13.4	2631	10.2	750	3.2
(b)	10/2400	4636	19.4	3562	14.3	1074	5.1
(c)	1/2400	5692	25.0	4265	17.6	1427	7.4

Reliance on interconnections to reduce generation reserves may appear attractive but it requires the systems to depend on each other to achieve the required reliability. If the interconnection capacity exists, the main risk is that either or both of the systems may have reserves substantially less than the required level because of errors in load forecast or inability to install generation on schedule. Also, government action may restrict the interchange of energy. Such factors may result in either or both of the systems suffering poor reliability for eight or more years because of the long lead time for new generation.

In the extremes, the alternatives shown in Figures 13-2 and 13-3 are mutually exclusive. That is, if the systems take maximum advantage from the increase in reliability, no generation reductions are possible. On the other hand, no increase in reliability will result if sufficiently large reductions are made in reserve generation capacity. However, it may be possible to achieve a portion of both these benefits at the same time.

Figures 13-2 and 13-3 deal with the increase in reliability of peak supply. Under some circumstances there will also be an increase in the reliability of energy supply. This would not be the case during periods of shortages of fuel which affect both of the systems.

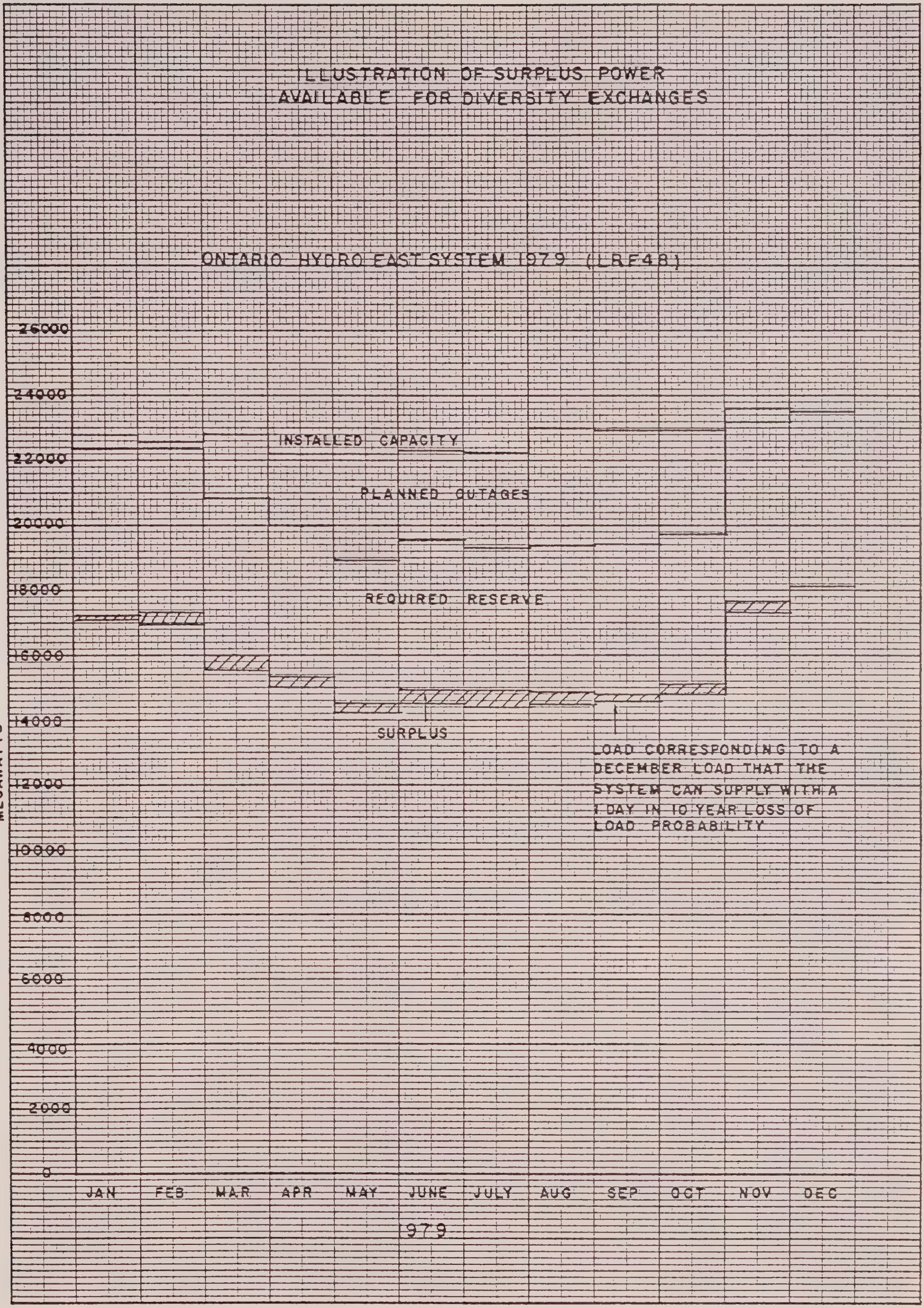


ILLUSTRATION OF SURPLUS POWER
AVAILABLE FOR DIVERSITY EXCHANGES
ONTARIO HYDRO EAST SYSTEM 1979 (LRF48)
MEGAWATTS
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
INSTALLED CAPACITY
PLANNED OUTAGES
REQUIRED RESERVE
SURPLUS
LOAD CORRESPONDING TO A DECEMBER LOAD THAT THE SYSTEM CAN SUPPLY WITH A 1 DAY IN 10 YEAR LOSS OF LOAD PROBABILITY
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
1979

FIGURE 13-4

ILLUSTRATION OF INCREASED YEAR ROUND LOAD THAT THE SYSTEM COULD SUPPLY BY REDISTRIBUTION OF SURPLUS POWER THROUGH DIVERSITY EXCHANGES

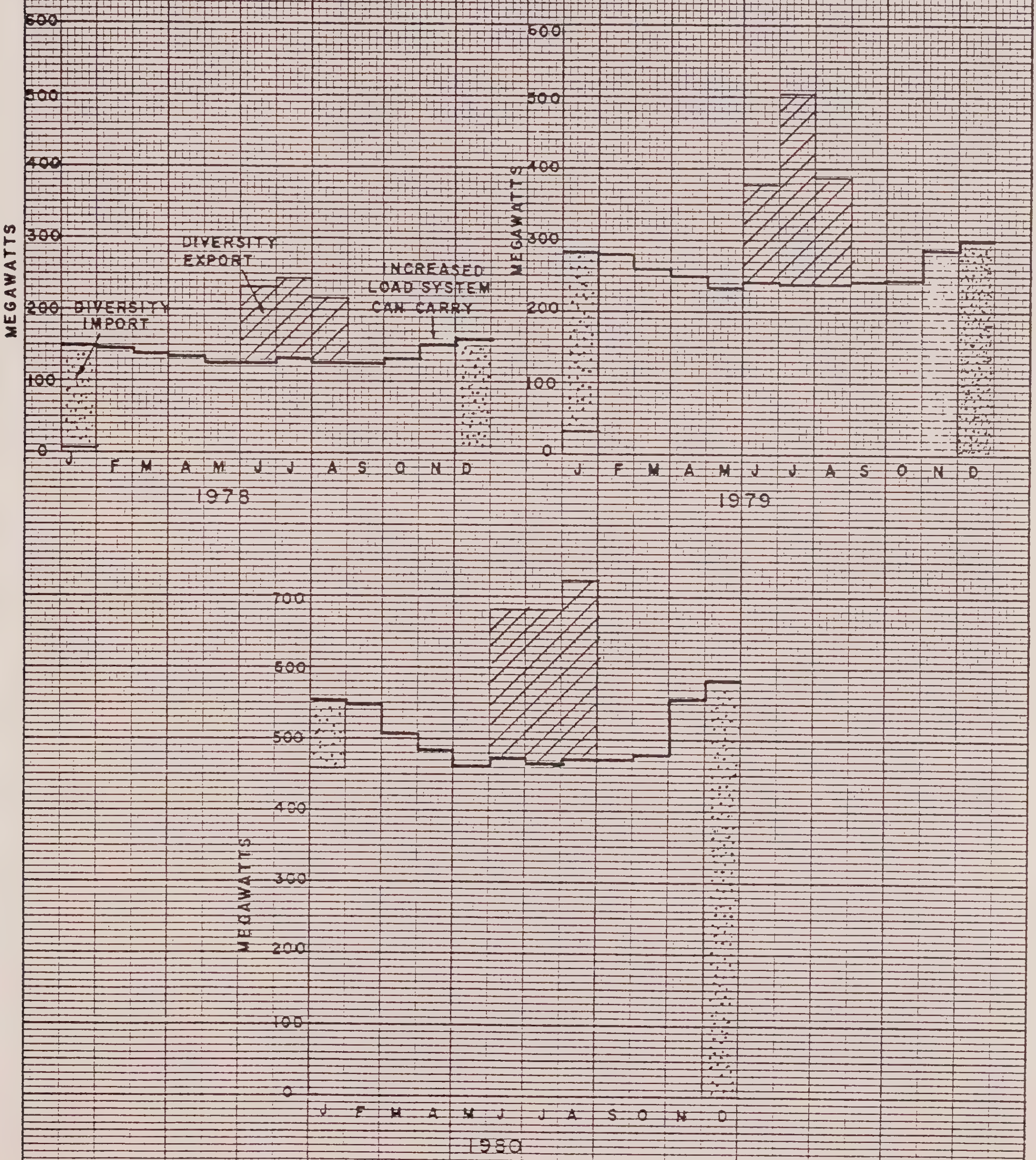


FIGURE 13-5

diversity exchanges to reduce its generating capacity program because of:

- possible limitations in transmission in intervening systems.
- possible government action to restrict energy transfers.
- the possibility that the intervening systems would use the power themselves if they should be in short supply.

<u>Daily Time-Zone Diversity</u>

Since Ontario, Quebec, New York and Michigan are all on Eastern Time there is no appreciable diversity between their daily peak load periods. Diversity does exist between Ontario and other parts of Canada but the benefit to be gained by Ontario from daily diversity exchanges with them is small, as shown in Figures 13-6 and 13-7, because:

- The other systems are much smaller than Ontario.
- There is a trend toward flattening of the daily load shape, and therefore the relative diversity in daily peak loads is expected to decrease.

(c) Advance or Joint Development

By making a firm agreement for sale over the interconnection extending over a period of a few years, one utility can install generating capacity in advance of its own need and sell it to another utility which can postpone installation of capacity on its system. This may be advantageous in the case of a major hydro-electric development where a large number of units are to be installed. Power is now purchased under short-term contracts from Quebec and Manitoba on this basis.

(d) Reduction in Transmission Requirements and Losses

With system interconnections there is usually a reduction in power and energy losses as a result of the additional transmission paths available.

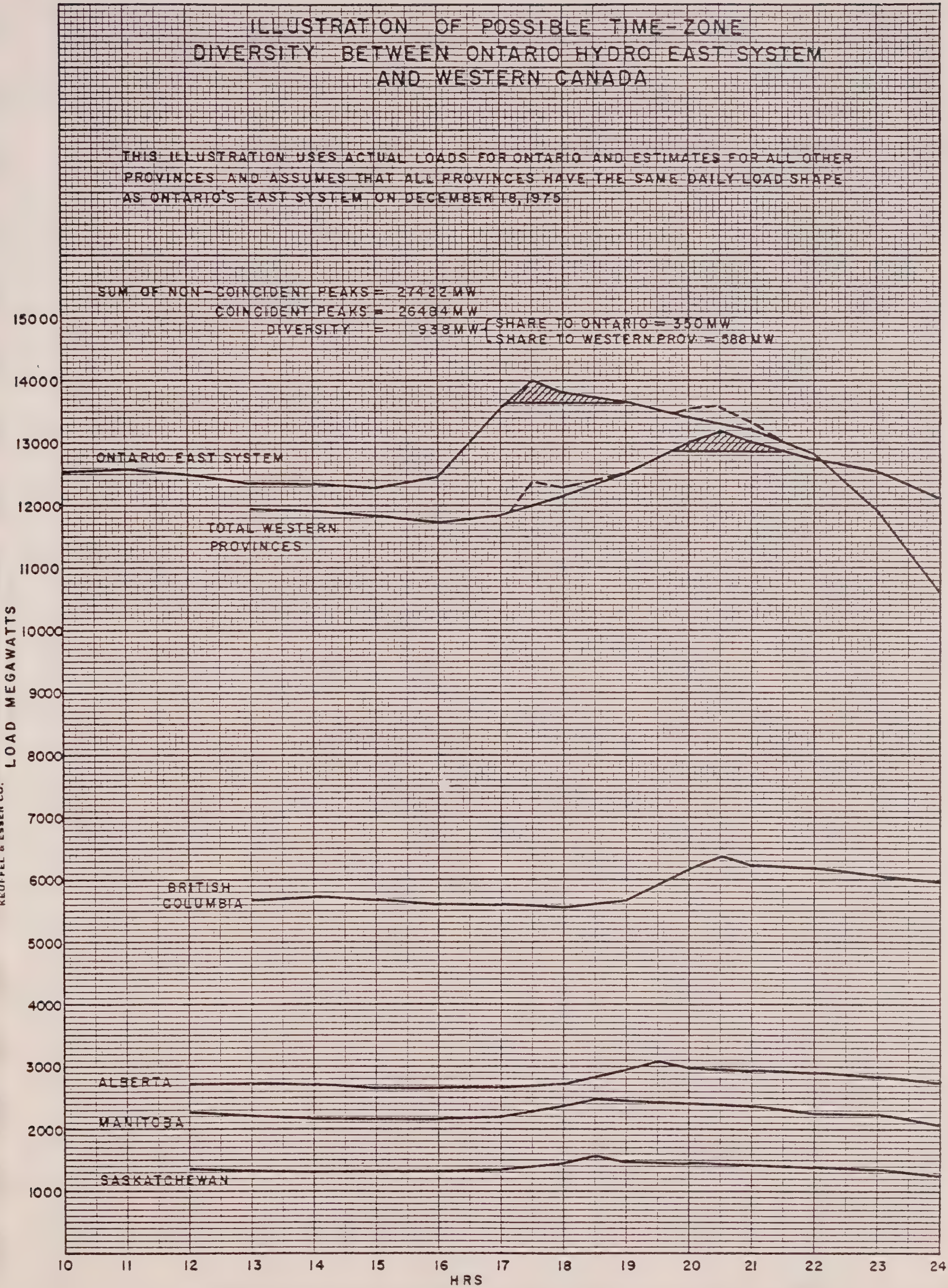


ILLUSTRATION OF POSSIBLE TIME-ZONE DIVERSITY BETWEEN ONTARIO HYDRO EAST SYSTEM AND WESTERN CANADA
THIS ILLUSTRATION USES ACTUAL LOADS FOR ONTARIO AND ESTIMATES FOR ALL OTHER PROVINCES AND ASSUMES THAT ALL PROVINCES HAVE THE SAME DAILY LOAD SHAPE AS ONTARIO'S EAST SYSTEM ON DECEMBER 18, 1975
SUM OF NON-COINCIDENT PEAKS = 27422 MW
COINCIDENT PEAKS = 26484 MW
DIVERSITY = 938 MW
SHARE TO ONTARIO = 350 MW
SHARE TO WESTERN PROV. = 588 MW
ONTARIO EAST SYSTEM
TOTAL WESTERN PROVINCES
BRITISH COLUMBIA
ALBERTA
MANITOBA
SASKATCHEWAN
LOAD MEGAWATTS
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HRS
KEUFFEL & ESSER CO.

FIGURE 13-6

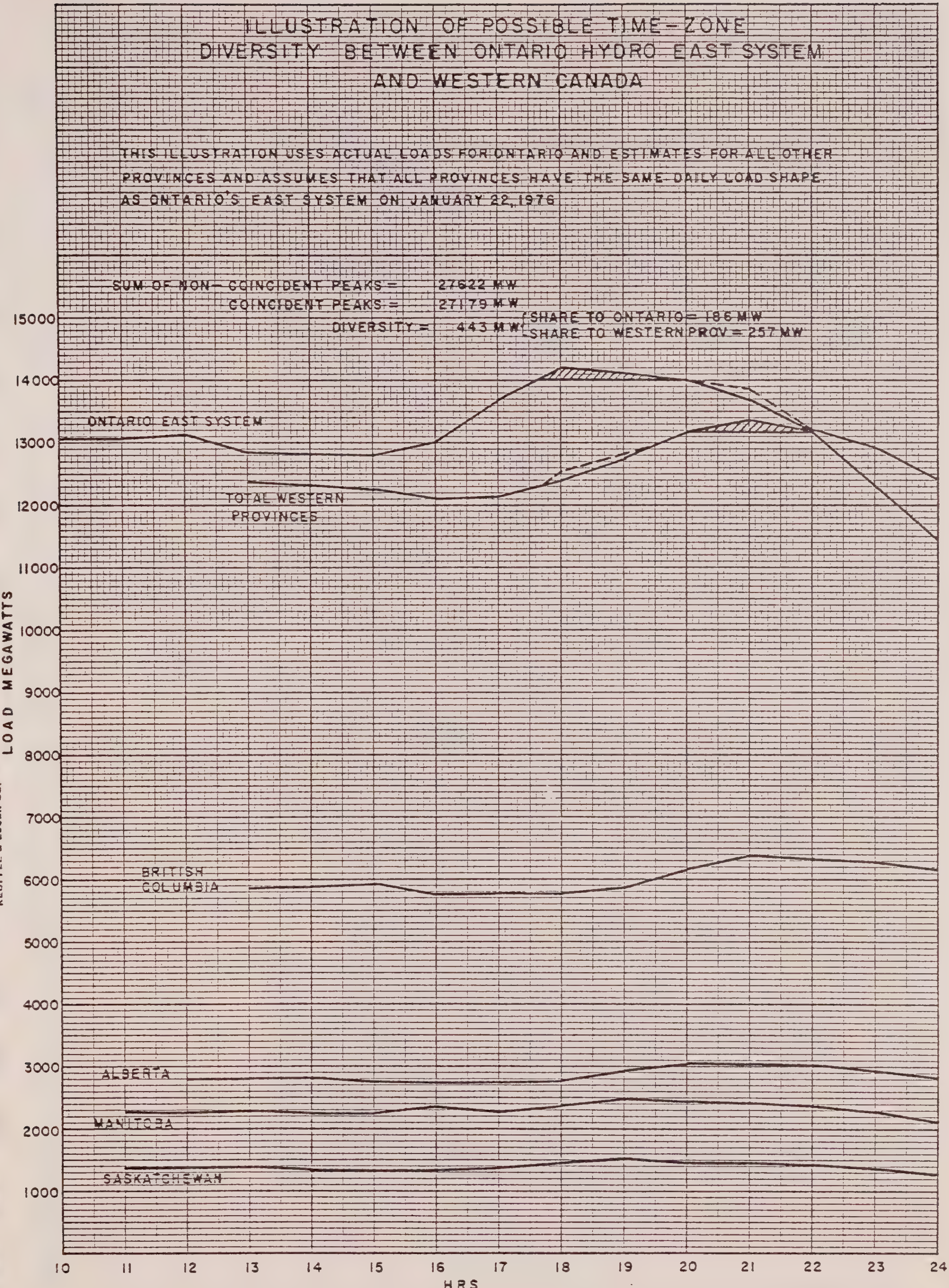


ILLUSTRATION OF POSSIBLE TIME-ZONE
DIVERSITY BETWEEN ONTARIO HYDRO EAST SYSTEM
AND WESTERN CANADA
THIS ILLUSTRATION USES ACTUAL LOADS FOR ONTARIO AND ESTIMATES FOR ALL OTHER
PROVINCES AND ASSUMES THAT ALL PROVINCES HAVE THE SAME DAILY LOAD SHAPE
AS ONTARIO'S EAST SYSTEM ON JANUARY 22, 1976
SUM OF NON-COINCIDENT PEAKS = 27622 MW
COINCIDENT PEAKS = 27179 MW
DIVERSITY = 443 MW
SHARE TO ONTARIO = 186 MW
SHARE TO WESTERN PROV = 257 MW
ONTARIO EAST SYSTEM
TOTAL WESTERN
PROVINCES
BRITISH
COLUMBIA
ALBERTA
MANITOBA
SASKATCHEWAN
LOAD MEGAWATTS
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
HRS

FIGURE 13 – 7

Also there may be a reduction in transmission requirements.

(e) Reduced Operating Reserve

Since each party to an interconnection has access to its neighbours' operating reserves and the parties are unlikely to require the reserves at precisely the same time, the amount of operating reserve which must be carried by each system can be less than it would have to carry if operating separately. This is an important advantage of interconnections because of the daily saving it produces.

(f) Improved Reliability Against Major Contingencies

Interconnections reduce the probability of interruption of load due to major contingencies such as those listed below, provided these contingencies do not affect both systems simultaneously:

- interrelated multiple outages or reductions in generating or transmission capacity.
- extreme weather effects.
- latefall in the in-service dates of new facilities.
- shortages of critical materials such as heavy water or fuel.
- malicious damage or sabotage.
- strikes.
- loads being much higher than forecast.

(g) Economy Transactions

One system may have surplus generating capacity which can produce energy at a lower cost than some of the higher cost generating units on a neighbouring system. Under these conditions a sale of power over the interconnections can provide both parties with cost advantages.

The table below shows the purchases of this type from the United States and other Canadian

provinces since 1970. About 85% of the purchases were from Canadian sources. The net savings are the generation cost that would have been incurred without the purchase less the gross cost of the purchases. (The economic benefits of economy sales are included in section (h) following.)

Year	Economy Purchases GWh	Purchase Cost M$	Net Savings M$
1970	1397	5.2	4.8
1971	584	1.6	1.3
1972	1617	4.7	4.0
1973	2040	5.3	3.8
1974	1601	6.3	5.0
1975	1577	8.1	6.6

(h) Economic Benefit from Sales

The preceding describes the benefit of energy imports or exchanges. The interconnections provide the means to deliver assistance to others in the form of interruptible sales, either to meet capacity shortages or to achieve economy savings. Such sales, made from resources which otherwise would be idle or only partially utilized, have resulted in substantial economic benefits as indicated by the following table. This table shows the energy sales outside Ontario since 1970, virtually all being to the United States. The net return or "profit" is the gross revenue received less the estimated incremental cost to Ontario Hydro of generating and transmitting the energy.

Year	Energy Sales GWh	Total Revenue M$	Net Return M$
1970	1582	17.6	6.3
1971	1777	21.9	6.4
1972	3755	36.3	16.1
1973	5362	61.2	31.7
1974	5890	101.1	54.7
1975	1967	42.1	20.1

The net return in 1974 of $54.7 million was equal to 6% of the 1974 primary revenue; i.e. it would have taken the equivalent of a 6% increase in 1974 primary rates to replace the "profit" on 1974 sales.

(i) Frequency Stability

With the present interconnection covering a large part of North America, it is possible to maintain system frequency much more constant than could be accomplished with an isolated system. The sudden change in frequency which occurs on failure of a generating unit is very small on a large interconnected system. This reduces the risk of damage to large turbine-generators installed at thermal plants. These units can be operated only for short periods at frequencies that differ even slightly from 60 Hz. Also electric motor speeds are more constant, an important consideration for some industrial users.

B. Disadvantages

The major advantages are obtained at the cost of some disadvantages.

- Interconnection facilities must be installed and expanded as the member systems grow in size. In addition some increase in system internal transmission may be required.
- Planning and operation of the power system becomes more complex because of constant co-ordination among member systems.
- Each system loses some autonomy in its planning and operation.
- Reliance on interconnection assistance to reduce reserves greatly increases the dependence of one system on the other. In the event that one system is unable to meet its reliability requirements this failure will be reflected in the lowering of the reliability of both systems.
- Occasionally, a disturbance on one system will cascade through the interconnection into another system, causing some interruption of load.
- Interconnected operation is an additional obstacle to the use of frequency reduction as a method of load curtailment.
- In addition changes in government policy may seriously restrict the value of interconnections, and unpredictably eliminate many of the advantages.

13.5 Existing and Planned Interconnections

A listing of Ontario Hydro's existing and planned 60 hz interconnections (115 kV and above) is shown in Figure 13-8, and the locations of these facilities are shown in Figure 13-9.

Interconnections with Quebec

Ontario Hydro has had major interconnections with Quebec since 1928. These were initially established to import power on long-term contracts of up to 44 years duration. They are located on the lower Ottawa River near Ottawa, and at the interprovincial border between Montreal and Cornwall. For technical reasons the Quebec main system cannot operate in parallel with the Ontario Hydro system. Therefore Hydro Quebec supplies Ontario with power by disconnecting generation from its system and connecting it to the Ontario system. At present Ontario Hydro can assist Hydro-Quebec in emergencies by allowing Quebec to withdraw generation supplying firm power to the Ontario system. In addition Ontario Hydro can assist Hydro-Quebec by isolating some Ontario generation on the Quebec system.

If the present firm contracts are not renewed, Ontario will be able to provide only limited support to Quebec in emergencies. The Ontario transmission system is not designed for easy isolation of major blocks of generation at Saunders or Lennox for export to Quebec. Furthermore, until transmission facilities in Eastern Ontario are expanded, any isolation of facilities to supply Quebec would jeopardize the supply to Ottawa. Interconnection by isolated generation does not provide the operating flexibility which is achieved on interconnections where the systems operate in parallel. However, direct interconnection of the main systems of Quebec and Ontario would require costly transmission additions.

There are also interconnections between Quebec's Abitibi system and Ontario Hydro's system in Northeastern Ontario. In addition to normal use, during the next few years, Ontario Hydro expects to provide assistance to Hydro Quebec's Abitibi system to meet forecast deficiencies in peak power and energy. However by 1980, Hydro Quebec expects to have completed a 735 kV line to interconnect its main system with its Abitibi system. Thereafter power exchanges between Ontario Hydro and Quebec's Abitibi system will only be possible by isolated generation.

ONTARIO HYDRO
EXISTING AND PLANNED 60 HZ INTERCONNECTIONS
115 kV AND ABOVE

Location	Designation Col. 1	Date Established (Note 1) Col. 2	Nominal Voltage kV Col. 3	Nominal Winter Capacity MVA (Note 2) Col. 4
QUEBEC				
Beauharnois	B5D	Oct. 1932	230	530
	B31L	Apr. 1941	230	530
Chenaux	X2Y	July 1942	115	65
Val Tetreau	V12 M	Nov. 1928	115	175
Val Tetreau	F10 MV	Nov. 1928	115	175
Masson	H4AK	July 1933	115	140
Masson	H9A	Aug. 1940	115	160
Paugan	P33C	Oct. 1928	230	315
Paugan	P4C	July 1930	230	315
Rouyn	K2R	Dec. 1949	115	85
Rapide des Iles	D3KZ	Oct. 1966	115	100
Holden	1331	Oct. 1966	115	145
MANITOBA				
Kenora	SK1	Oct. 1956	115	75
	K21W	Oct. 1972	230	200
	K22W	Apr. 1973	230	200
GREAT LAKES POWER				
Mississagi	P21G	Dec. 1968	230	250
	P22G	Dec. 1968	230	250
Wawa	T_1	Jan. 1969	115	125
	T_2	Jan. 1969	115	125
NEW YORK				
Niagara	PA27	Dec. 1961	230	480
	BP76	May 1955	230	550
Cornwall	L33P	Dec. 1958	230	360
	L34P	Future(4)	230	360
MICHIGAN				
Sarnia	B3N	Sep. 1953	230	590
Windsor	J5D	Sep. 1953	230	570
Lambton	L4D	Dec. 1966	345	800
	L51D	1976	345	895

NOTES:

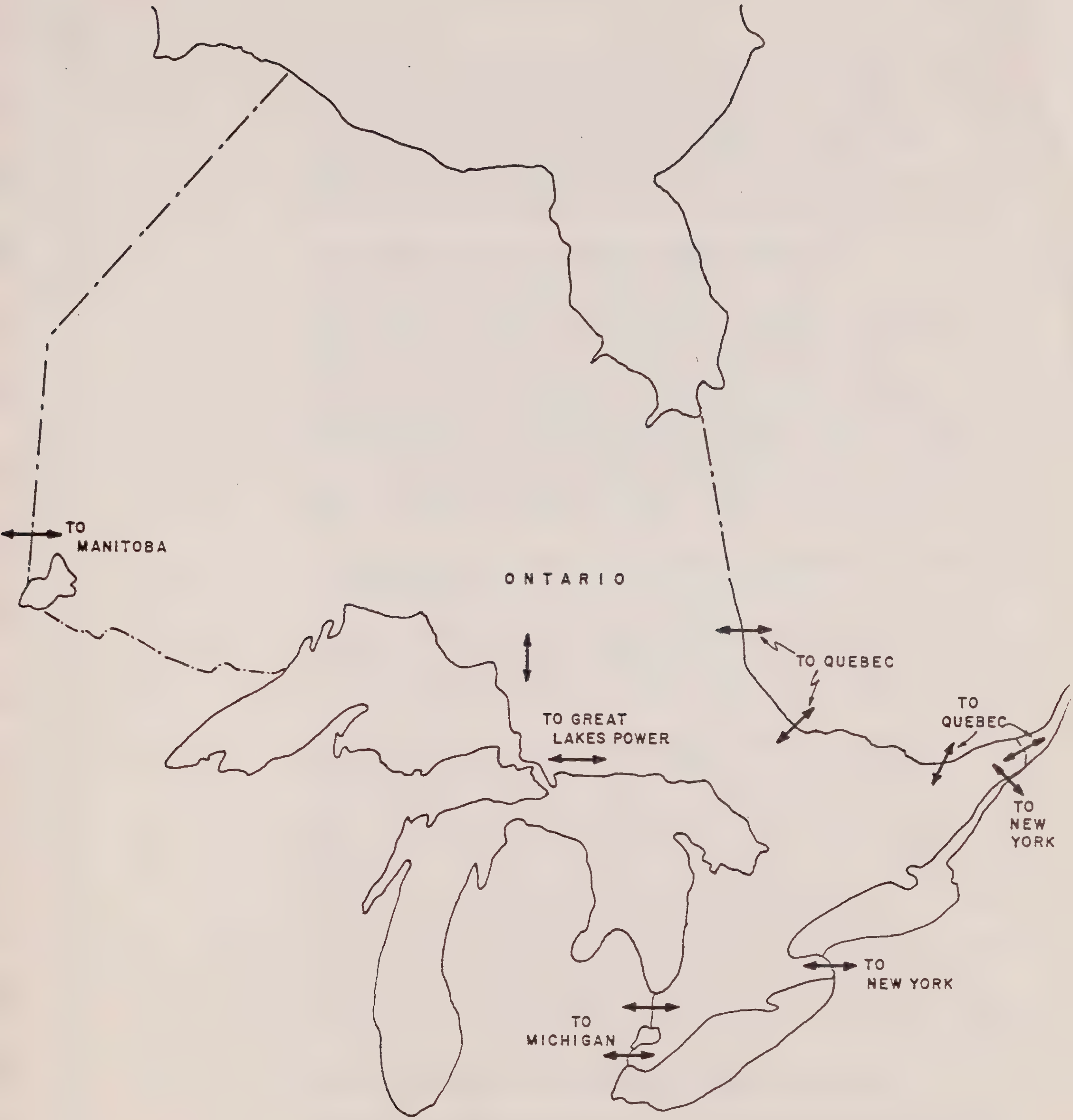
(1) The "date established" is the in-service date of the original interconnection. Changes to some of the interconnections have been made since to increase the voltage and/or the capacity.

(2) The Nominal Winter Capacities are based on the more limiting of the line or transformer capacity included in the interconnection.

(3) The total permissible interchange with the various utilities is not the arithmetic sum of the nominal capacities of the interconnections with that utility because power flows may not be shared by the interconnections in proportion to their capacities.

(4) L34P was originally placed in-service as HM3 in 1947 at 115 kV. It has not been used in recent years. Present plans are to re-establish this tie, with a phase shifter, for 230 kV operation.

FIGURE 13-8



GEOGRAPHIC LOCATION OF INTERCONNECTIONS

FIGURE 13-9

Although the total capacity of the interconnections with Quebec listed in Figure 13-8 is 2720 MW, system transmission considerations limit the transfer capability to Ontario to 1300-1500 MW, and the capability to Quebec to 300-500 MW. Unless transmission is added, the limits will decrease in future years because of load growth near the border.

Interconnections in Northeastern Ontario

Because of the large distances and small population, development of an interconnected system in Northern Ontario occurred later than in Southern Ontario. Isolated systems of Ontario Hydro and private companies in Northeastern Ontario were integrated by Ontario Hydro transmission lines and eventually interconnected with the main Southern Ontario system in 1950. The area around Sault Ste. Marie is supplied by a private company, Great Lakes Power Corporation, which has been interconnected with Ontario Hydro since 1960.

Interconnection with the Ontario Hydro West System and Manitoba

Ontario Hydro's West System supplying the area from Marathon to Kenora developed as an isolated system. It was interconnected with the Manitoba system in 1956 and with Ontario Hydro's East System in 1970.

The first interconnection with Manitoba Hydro (designated SK1) was established in 1956 by the construction of a 115 kV line from Kenora TS to Manitoba Hydro's Seven Sisters Generating Station. Two 230 kV interconnections (K21W and K22W) between Kenora and Manitoba Hydro's Whiteshell station, were placed in service in October 1972 and April 1973, to accept the firm power deliveries commencing in 1972. The interconnections include phase-shifting transformers. Manitoba Hydro is also connected to the Saskatchewan Power Corporation and to the United States systems in North Dakota. These in turn are connected to the continental grid in the United States so that a parallel loop exists around the Great Lakes.

Interconnections with Michigan and New York

The first 60 Hz interconnections with Detroit Edison were established in 1953, a 115 kV interconnection (M3S) between Ontario Hydro's Sarnia Scott station and Detroit Edison's Marysville station and a 115 kV interconnection (J5D) between Keith Generating Station

at Windsor and Detroit Edison 's Waterman Station. Provision was made in the construction of these interconnections for future conversion to 230 kV operation. In 1966 a third 115 kV interconnection, (L4D) with provision for future conversion to 345 kV was established between Lambton GS and Detroit Edison's St. Clair Power Plant.

In 1968, L4D was converted to 345 kV operation. M3S and J5D were converted to 230 kV operation in April 1973 and May 1973 respectively and a phase-shifting transformer was installed in J5D in 1975. A second 345 kV interconnection from Lambton to St. Clair was recently placed in service.

Initially, Ontario Hydro had limited export capability with Niagara Mohawk using the 69 kV, 25 Hz tie lines at Niagara. Also, at times, power was exported at Cornwall using a 60 Hz circuit designated HM3 and operating at 115 kV, which was rented from the Cedars Rapids Transmission Company.

The first permanent 60 Hz interconnection with New York was established in 1955 at 230 kV between Beck GS and the Packard station of Niagara Mohawk (BP76). In 1958, a 230 kV interconnection at Cornwall (L33P) was established with PASNY and includes a phase-shifting transformer. A second 230 kV interconnection (PA27) was constructed between Beck GS and the Niagara station of PASNY in 1961 and a second 230 kV interconnection at Cornwall is planned for service in 1978.

All interconnections with the United States have voltage regulation on the transformers.

13.6 Interchange Capability and Circulating Power

The total capacities of the interconnections listed in Figure 13-8 are 2855 MW for transfers with Michigan and 1750 MW for transfers with New York. However, because the flows on the interconnections cannot be precisely controlled, and because there are transmission limitations in Ontario and the United States, the range of export and import capabilities following completion of the second 230 kV interconnection at Cornwall in 1978 is as follows:

Export from Ontario	1000 to 2500 MW
Import to Ontario	1500 to 3000 MW

A complicating feature of operation of the interconnections with Michigan and New York is the circulating power around Lakes Erie and Ontario. Even with no net import or export there is usually a flow of power over the interconnections, with power leaving Ontario for New York and simultaneously returning to Ontario from Michigan, or vice versa. The flow of circulating power sometimes reaches 600 megawatts. A net export under these conditions will increase the flow out of Ontario to New York and decrease or possibly reverse the flow into Ontario from Michigan, or vice versa. Circulating power therefore necessitates considerably larger capacity on individual tie lines than would be the case if precise control of all ties were possible, but it does have the advantage that it reduces total transmission losses by providing a greater number of transmission paths over which the power may flow.

A measure of control of circulating power is possible by two techniques, both of which are costly and result in an increase in total transmission losses:

- Phase-shifting transformers can be installed in the interconnections, as has been done at Cornwall, Windsor and Whiteshell, Manitoba.

- High Voltage Direct Current interconnections can be used. This method of control has not been used by Ontario Hydro.

Figure 13-10 shows the transfer limits with existing and planned interconnections after allowance for circulating power and other factors.

13.7 History of Exports and Imports with the United States,

Almost immediately after the first two interconnections with Michigan were placed in-service in 1953, Ontario Hydro started buying emergency assistance to offset low water conditions and the major failure of the Hearn plant in 1954. Although the quantities were small by today's standards, this assistance was of critical value at the time. Even under these adverse conditions, some export sales were possible at other times of the year, during spring freshet and low load conditions.

By the late 1950's the situation had reversed. Resource conditions, particulary stream flows, were favourable in Ontario. Niagara Mohawk had lost the output of the entire Schoellkopf generating station as

TRANSFER LIMITS IN LATE 1970's
WITH EXISTING AND PLANNED INTERCONNECTIONS

IMPORT

	MW
Quebec	1300 to 1500
Manitoba	200 to 300
Great Lakes Power	*
United States	1500 to 3000

EXPORT

Quebec	300 to 500
Manitoba	0 to 100
Great Lakes Power	150 to 250
United States	1000 to 2500

Note: The Great Lakes Power Co. load normally exceeds their generating capacity. Surplus power is available very infrequently.

June 14, 1976

FIGURE 13 - 10

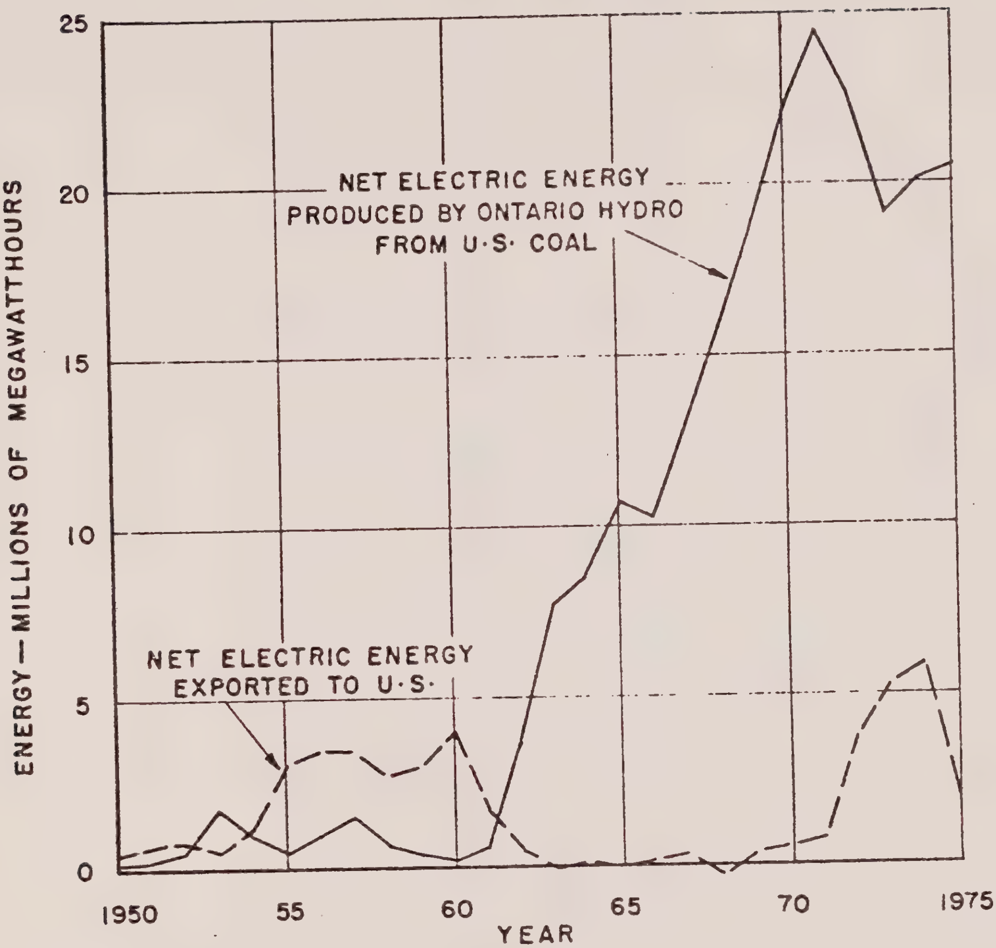
a result of a rockslide in the Niagara gorge. Large sales, mostly from hydraulic sources, were made to displace fossil-fuelled generation in New York and Michigan or to provide capacity assistance to Niagara Mohawk.

In the mid 1960's, with very poor water conditions and commissioning problems at Lakeview GS, electricity purchases usually exceeded sales. In 1968, for example, Ontario purchased emergency assistance from the United States to meet capacity shortages on 81 occasions in amounts up to 550 MW. Meanwhile coal purchases for thermal stations were rising rapidly. In the early 1970's, the load-resource situation deteriorated in the neighbouring United States systems and improved in Ontario. With favourable water conditions in Ontario, and the excellent performance of Pickering GS, Ontario Hydro had surplus capacity available most of the time to assist the hard-pressed American utilities.

In late 1973 and early 1974, the Arab oil crisis added a new factor. The American systems purchased energy almost continuously whenever surplus generation was available to displace their oil-fired units. The assistance from Ontario Hydro, using American coal, was a significant factor in easing the effect of the oil crisis in the Northeastern United States. In December, 1974, Ontario Hydro, with five 500 MW units out-of-service for an extended period, again required assistance, and a total of 510 MW of reserve capacity was purchased from the United States.

In 1975, largely as a result of the recession in the United States, the situation again changed suddenly and export sales dropped to about one-third the record 1974 quantities. With almost no load growth in 1975, the American load and capacity balance had improved so that only occasional assistance was required throughout the year to cover equipment outages or to displace higher cost generation.

Ontario Hydro is now dependent on United States coal for a large portion of its electric energy supply. Figure 13-11 shows net electric energy generated by Ontario Hydro from coal imported from the United States and net electric energy exports to the United States since 1950. The graph shows that the electric energy produced from imported coal has for many year greatly exceeded the electric energy exported. Figure 13-12 shows the export and import electricity transactions with the United States since 1950. This



ONTARIO HYDRO

ENERGY INTERCHANGES WITH UNITED STATES

(EXCLUDING BORDER ACCOMMODATIONS)

FIGURE 13-11

GROWTH OF INTERCHANGE TRANSACTIONS WITH THE USA
ENERGY SALES AND PURCHASES

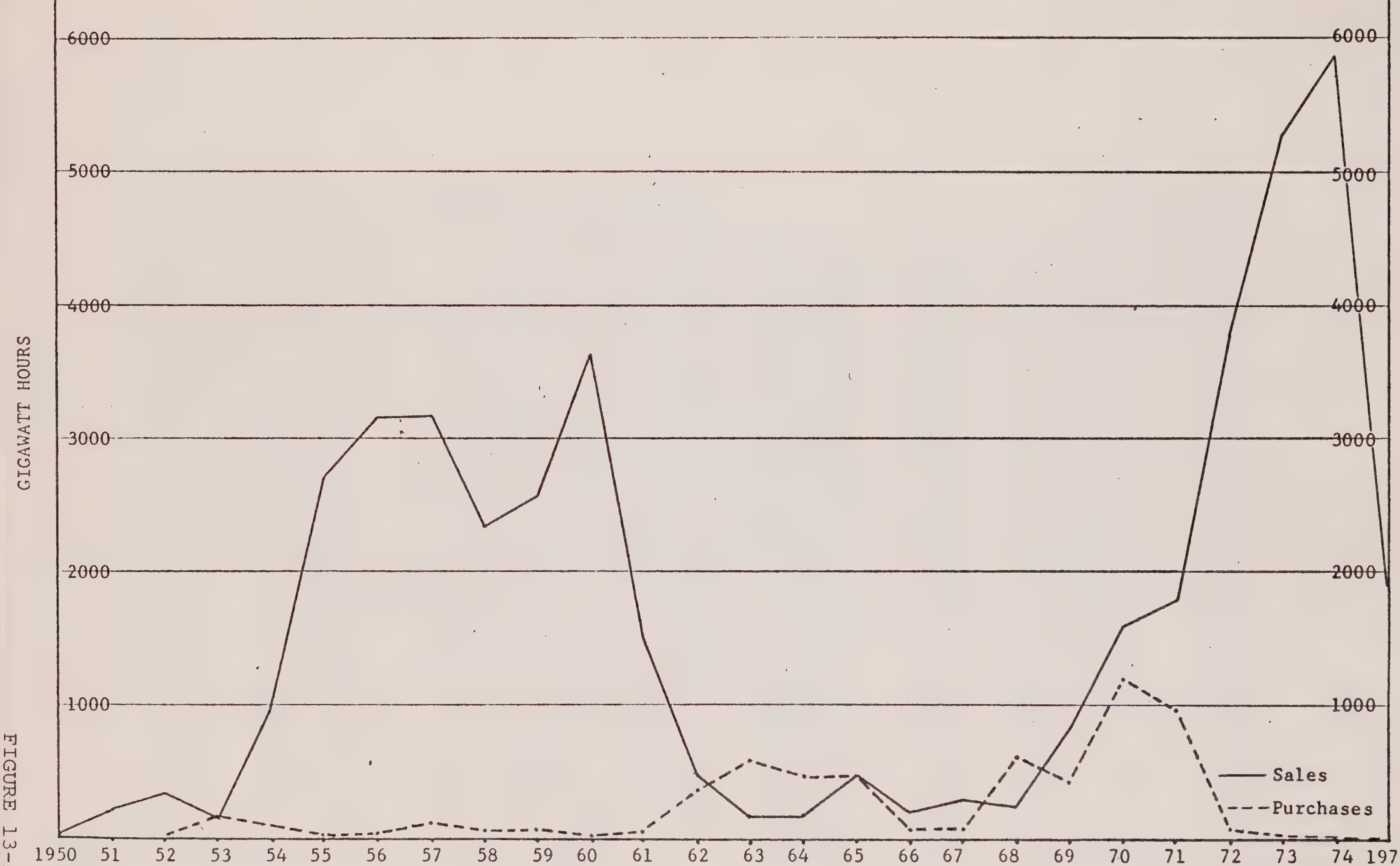


FIGURE 13-12

FIGURE 13-12

graph reflects the variations over the years in resource availability, requirements for emergency assistance and opportunities for profit.

13.8 Export Policy

Exports to customers outside Ontario are defined under the following three classifications:

- Firm Export - Export sales which are given approximately equal priority with firm loads in Ontario.
- Interruptible Export - Export sales which have a lower priority than Ontario loads and which would be interrupted to protect the reliability of supply in Canada.
- Inadvertent Equichange - Offsetting inadvertent or unscheduled exports and imports of electricity which are a natural result of operating two or more systems in parallel. These equichanges do not involve any net export of energy from Canada and are not classified as "sales".

Ontario Hydro does not at present supply firm power directly to utilities or end users outside Ontario, except as a matter of "border accommodation" to certain customers in the United States who are difficult or impractical to supply from an American utility but can more easily be served from a Canadian utility and vice versa. There are three exports and two imports to Ontario of this type. The largest is a sale of about 30 megawatts to the Ontario-Minnesota Pulp and Paper Company at Fort Frances, which it exports to the Boise Cascade Company at International Falls. The total of these firm exports by Ontario Hydro represent less than two-tenths of one percent of Ontario Hydro's 1975 installed capacity.

Future firm exports, if any, would be a matter of negotiation between the parties concerned and would be considered in terms of the overall merits of the specific proposal. Any contract for such exports would require the approval of the Provincial Cabinet and, in the case of exports to the United States, the National Energy Board.

The policy on the export of surplus interruptible power is as follows:

"In order to obtain the benefits of improved quality of service, improved reliability, and reduced cost of service to Ontario Hydro customers that are provided by the necessarily-reciprocal agreements for participation in the interconnected network, it is the policy of Ontario Hydro to export surplus interruptible power in accordance with the following:

"(a) to provide emergency assistance to the maximum extent deemed consistent with the safe and proper operation of its own system and with its prior obligations to other Canadian systems;

"(b) to take advantage of opportunities for profitable sales at times other than emergencies in such quantities as deemed desirable, having due regard for conditions on the Ontario Hydro system;

"(c) to obtain a fair and economic return for the services provided and to maximize the longer term economic gain to Ontario, taking into account all applicable costs incurred in Canada and having due regard to the possibility that Ontario Hydro may need to purchase in future under the same conditions;

"(d) to adhere to the Corporation's policies on the conservation of energy and to any applicable governmental rules and regulations, including those relating to the use of resources, environmental restrictions, priority of supply and quantities that may be exported."

13.9 Export Licence for Interruptible Power and Energy

Any interconnection agreement requires the approval of the Government of Ontario. Any export of power to the United States must meet the terms of a license granted by the National Energy Board.

The minimum requirements for granting an export license, as stated in the National Energy Board's 1974 Annual Report, are as follows:

> "Applicants for licences to export power must satisfy the Board that the energy proposed to be exported will be surplus to reasonably foreseeable Canadian needs.
>
> "To ensure that export prices are just and reasonable, an applicant must also satisfy the Board that the price will cover the cost of

producing the power and transmitting it to the border, that it will not be less than the price to Canadians for comparable service, and that it will not be markedly less than the lowest cost alternative to the purchaser. The value to Canada of related imports is also taken into account."

In March 1976 Ontario Hydro applied for a licence for two basic types of surplus interruptible energy exports. The first type consists of unscheduled transfers of inadvertent energy over the interconnections as described in section 13.6. The second type consists of scheduled transfers of all other classifications provided for in the interconnection agreements.

There are no obligations in these agreements to export and import any specific quantities of energy. Because of the many variables and uncertainties involved, the volume of exports and imports cannot be predicted with accuracy. The range of variability is illustrated by Figure 13-12, which shows the history of export sales and purchases since 1950. The following table is an estimate of the potential maximum energy exports of each basic type that could occur in any individual year. These are the amounts that Ontario Hydro has used in its application for an export licence.

Year	Inadvertent Equichange (Gwh)	Scheduled Transfers (Gwh)
1976	6,000	10,000
1977	7,000	13,000
1978	8,000	13,000
1979	9,000	15,000
1980	10,000	18,500
1981	11,000	20,000
1982	12,000	23,000
1983	13,000	26,000
1984	14,000	28,000
1985	15,000	30,000

13.10 Import Policy

Ontario Hydro is prepared to purchase power from other utilities when this is advantageous. At present Ontario Hydro purchases firm power from Quebec and Manitoba, but not from United States utilities.

Line Number

Adjacent regions in the United States have in recent years been experiencing severe difficulties in obtaining:

- the necessary approvals for constructing new generating and transmission facilities,

- gas, oil and low sulphur coal to run existing plant, and,

- the necessary capital to build new facilities.

In view of these conditions, it is unlikely that firm power at an acceptable price and reliability level can be purchased from United States utilities in the foreseeable future. Possible future firm purchases from Quebec and Manitoba are being investigated, as described in Section 13.14.

Interruptible power is purchased from other utilities, if available, when such purchases are advantageous for either operating or economic reasons.

The import of electricity from the United States is not subject to National Energy Board licensing.

13.11 Interconnection Agreements

Utilities, in dealing with neighbouring utilities, operate under formal interconnection agreements or their equivalent. These agreements make provision for sharing of reserves, emergency and economy transfers, seasonal diversity transfers, co-ordinated maintenance and possible co-ordinated development and they provide the ground rules for the day-to-day operation of the power system.

Ontario Hydro has formal interconnection agreements with:

- Hydro-Quebec

- Manitoba Hydro

- Great Lakes Power Corporation

- Niagara Mohawk

- PASNY

- Michigan (Detroit Edison and Consumers' Power)

- Ontario-Minnnesota Pulp and Paper Company

A typical agreement provides:

- a statement of licence and government authority, if necessary;
- a description of interconnection facilities and metering points, and billing practices;
- a description of various types of electric service that can be provided;
- for the establishment of formal operating and planning committees, outlining their duties and authorizing them to carry out the provisions of the agreement;
- a statement of liability;
- a statement of effective date and term;
- other legal requirements.

Ontario Hydro's interprovincial and international interconnection agreements are given in Reference 1.

13.12 Financial Benefits of Interconnections

Interconnections not involving long-term purchases or sales do not lend themselves to cost-benefit analysis because the tangible benefits cannot be estimated very far into the future. Many of the benefits come from daily operating cost savings and these are very difficult to estimate even a few years in the future.

The tangible benefits from non-firm interchanges can be substantial, but variable as in the export to the United States, where net profits varied from $54,700,000 in 1974 to $20,000,000 in 1975. Past experience has shown tangible benefits to be significant in most years, but this is little help in forecasting. Also some major benefits such as improved reliability, cannot be estimated in financial terms.

While the benefits cannot be quantified over the long term, the investments necessary for most of Ontario Hydro's interconnections have been relatively small. They have involved two or three circuit breakers, a regulating transformer, and a few miles of transmission line, with the costs shared by the

utilities involved. The decision to install them has been made largely on a basis of intangibles and judgement based on past experience. If future Ontario Hydro interconnections involve large expenditures for internal transmission, more evidence of benefits may be required before a decision is made to proceed.

Interconnections built for specific firm power purchases and sales are more amenable to cost-benefit analysis during the period of the firm agreement. Assessment of the value of the interconnection in later years is subject to the difficulties expressed above.

13.13 Planning New Interconnections

Interconnections are generally planned and constructed by the utilities directly involved. Planning for expansion of interconnections to meet the changing requirements of growing systems is an ongoing process, just as is planning for expansion of the Ontario Hydro system to meet growing loads. Extensive studies are carried out to assess the capabilities of existing interconnections with time, assess the benefits of additional interconnection capacity, develop and assess effects of alternatives on the performance of the system, prepare technical specifications and cost estimates, assess justification of additional capacity and reach agreement on sharing of cost.

Each utility is responsible for obtaining the necessary Government approvals within its jurisdiction. For example Ontario Hydro would have to obtain the approval of the Government of Ontario and a license from the National Energy Board for major expansion or contruction of an international connection.

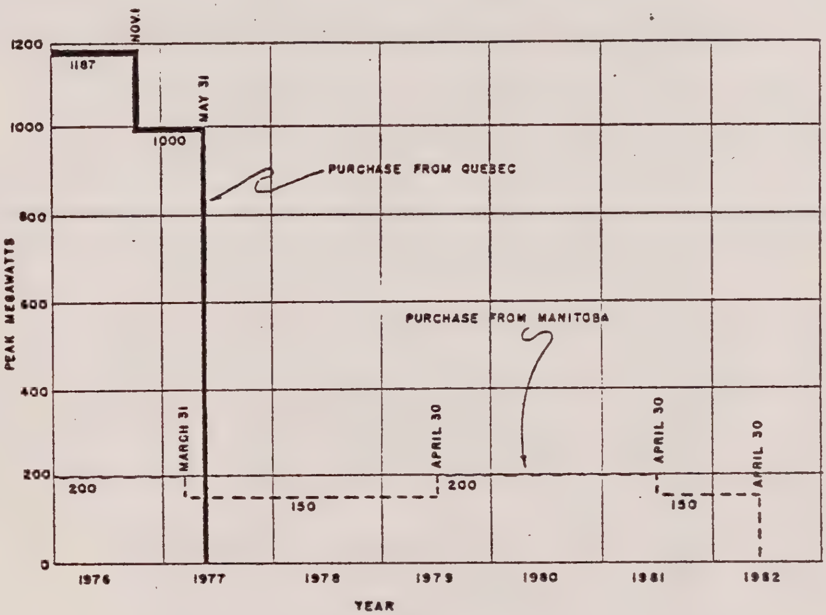
13.14 Purchases and Sales

Ontario Hydro has frequent discussions with neighbouring utilities concerning possible opportunities for purchases and sales. The Operations Branch co-ordinate Ontario Hydro's interconnection purchases and sales for about two years into the future. This consists of arranging short-term interruptible sales that provide interruptible emergency issistance and economy transactions. For the longer term, when purchases can affect the installation of new facilities, the planning and operating functions deal jointly with the other parties to the interconnection arrangements.

Firm Purchases from Other Provinces

Ontario Hydro has had a long history of firm power purchases. It has purchased firm power from Quebec since the 1920s, and from Manitoba since 1972. These purchases were made when Ontario Hydro required power and when it was available at advantageous prices.

The firm purchases currently covered by contract or letter of intent are:



The contracts and agreements for the above firm purchases reflect the recent fundamental changes that have taken place in the nature of firm purchases.

187 MW of the purchase from Quebec terminates on November 1, 1976. This contract was originally executed in 1929, and was amended a few years later. The amended agreement provided fixed amounts of power and energy which ratchetted up in the initial years. The final amount of 187 MW has been supplied for almost 40 years, at a fixed price and has been associated with a specific generating station at Beauharnois. Several similar long term purchases were made from other Quebec sources but these have already expired.

The remaining 1000 MW purchase from Hydro-Quebec will terminate on May 31, 1977. This is purchased under two agreements of much shorter duration than for the 187 MW mentioned above. The first agreement was executed on October 2, 1970, and stipulated the delivery of certain amounts of interruptible energy starting June 1, 1971, and of firm power and energy starting June 1, 1975, all purchased at fixed prices. The second agreement was executed on November 24, 1971, and provided additional energy and firm power at higher prices, which included the concept of varying price for the additional energy that escalates by stated amounts, year by year. This power and energy was not related to a specific generating station but in effect it became available as a result of a temporary surplus in Quebec associated with the Churchill Falls hydroelectric development.

A similar situation applies to the purchase from Manitoba Hydro. This represents three agreements each of short duration. The first was executed on November 16, 1971, and provides certain amounts of firm power and energy for delivery up to March 31, 1978. These purchases are at a fixed price. The second was executed on January 30, 1974 and May 21, 1974, and the third on May 28, 1975. They provide power and energy in the period April 1, 1977 to April 30, 1982. The second and third agreements have common terms and price. This price is to be related to specific actual escalation factors and actual interest rates that occur up to 1980. In essence these agreements were made possible by a temporary surplus in Manitoba associated with Kettle Rapids for the first agreement and Long Spruce for the last two agreements. These are both hydroelectric developments.

Thus, the nature of recent firm purchases has changed from the earlier concept of fixed amounts of power and energy supplied for long periods of time at fixed prices, to the concept of supply:

- for relatively short periods of time, associated with temporary surplus capacity on the seller's system.

- at variable prices, related to estimated or actual future escalation rates.

These temporary surpluses on the seller's system have resulted from the power and energy from large-scale hydroelectric developments overrunning the seller's own requirements, or the deliberate advancement of

some stages in these developments in order to achieve surplus for use in firm sales to markets outside the seller's system.

Prices now quoted by sellers tend to be at least the larger of either the average cost of his new developments or the average price to his own firm customers. Higher prices than these are quoted if the seller believes the market will bear them.

Up to the present, sellers have not required Ontario Hydro to provide capital contributions toward development of generating stations. Current indications are that they may require such contribution for future large scale firm sales.

These changes in conditions of sale tend to render purchases less attractive, by reducing the advantages formerly available to the purchaser, namely:

- a reduction in the amount of capital the purchaser must raise. (If capital contributions are required in future purchases.)

- low prices associated with the incremental cost of advancing new projects or with surplus sales. (If prices are based on average project costs or on rates charged to the seller's own customers, and these are greater than incremental cost. The seller may consider such prices to be necessary from the provincial political viewpoint.)

This is of particular concern where the seller is developing hydroelectric capacity, on the assumption that the energy production costs from alternative thermal plants that he could develop will continue to escalate in the future. In such cases, the average cost of the hydroelectric development, although lower than thermal plant costs in the long run, may be higher in the early years when the seller has excess power and energy to sell to Ontario Hydro. Thus, the selling price to Ontario Hydro would be higher than Ontario Hydro's costs from alternative thermal plants.

Two major factors affecting the benefits of firm purchases are their nature (whether they are derived from thermal or hydroelectric generation) and the extent to which idle electric transmission and fossil fuel transportation facilities exist in the areas involved.

The cost of transmitting electrical energy long distances tends to be higher than the cost of transmitting equivalent fossil fuels by rail, ship, or pipeline. This is particularly the case where usable rail facilities are already available. It may not be the case where little, if any, new electric transmission must be constructed and where rail rates are rigidly structured to reflect average historical costs rather than the incremental costs of rail delivery. Thus, when the present 200 MW purchase from Manitoba Hydro expires, it may prove less costly for Ontario Hydro to import electric power instead of additional coal from Saskatchewan. This possibility is being investigated but it depends upon the reliability of the Manitoba Hydro system and their willingness to transmit power from Saskatchewan to Ontario.

Hydroelectric energy must be transmitted electrically. If this requires new transmission, a large cost penalty may be involved. However, with Ontario Hydro's proposed tranmission systems, by the end of the 1970s it could import 1000 MW to 1200 MW from Hydro-Quebec and 200 MW to 300 MW from Manitoba.

Ontario Hydro is continuing its past practice of pursuing the possibilities of making firm purchases from other provinces and making such purchases when they are advantageous. This is done by periodically reviewing the possibility of purchases from Hydro-Quebec, Manitoba Hydro, and Saskatchewan Power Corporation.

The current status of these discussions is as follows:

<u>With Hydro-Quebec</u>

Discussion are on going to determine whether further purchases can be made. Hydro-Quebec has informed Ontario Hydro that it will not have surplus firm power available in the winter months with its committed generation program. It has also advised that advancement of the committed generation program is not possible and it is unlikely that Hydro-Quebec would advance future commitments without a capital contribution. Negotiations are also underway for a purchase of interruptible energy of three million GWh per year from June 1977 to May 1982.

Because the mainly hydro-electric system in Quebec and the mainly thermal system in Ontario are complementary, there is scope for emergency and

economy transfers between the two systems even if firm power is not available. Therefore, a planning study is being initiated between Quebec and Ontario to consider the possibility of additional interchanges and interconnection facilities.

Among the alternatives to be considered is a direct-current link. Such a link would provide most of the benefits of normal interconnected operation and would reduce the need to effect power transfers by isolation of generation from one system to another. As explained earlier, a parallel ac interconnection between the two systems is not practical for technical reasons.

With Manitoba

Manitoba Hydro has indicated that they might be able to extend their sales at a level of 100 MW in 1982/83, following termination of existing agreements. This will be the subject of continuing discussions.

With Saskatchewan

A preliminary proposal has been made by Saskatchewan Power for the sale of up to 300 MW starting in 1981. It would be necessary to involve Manitoba in this transaction.

Purchases and Sales with United States Utilities

Discussions have been held regarding the possible purchase by Michigan of interruptible power and energy in the order of 1000 MW for the six summer months in 1978, 1979, and 1980.

13.15 National/Provincial Grid

As described in previous sections, Ontario Hydro has interconnections with the neighbouring provinces of Quebec and Manitoba. Likewise interconnections have been developed between Manitoba and Saskatchewan, between Alberta and British Columbia and between Quebec and New Brunswick and Nova Scotia. All these interconnections developed from the requirements of adjacent provinces, rather than from considerations of Canada as a whole.

A major study was carried out in the 1960's by a Federal - Provincial Ministerial Committee to consider a high capacity transmission grid interconnecting all provinces of Canada. The recommendations of that

Committee, given in their report of July 1967, were that further studies of the national network should be deferred for the time being, but that consideration should be given to strengthening regional ties. Those recommendations were similar to Ontario Hydro's views, and the interconnections between Ontario and Manitoba and Quebec have been strengthened since 1967.

Proposals for further study of a National Grid, or at least of major interprovincial grids in eastern and western Canada, have been raised several times since 1967. In 1973 a proposal was made for an Eastern Canada Grid, as a means of facilitating development of nuclear power in Nova Scotia and hydro power in Labrador. The National Grid was raised again in January 1974 at the First Ministers' meeting on energy, and the Federal Government offered to assist financially in studies. In early 1975 the Interprovincial Advisory Council on Energy (IPACE) initiated a study of a National Grid. This study is at the stage of finalizing its terms of reference.

In addition to the proposed IPACE studies there are two major studies of regional grids now underway:

1. Quebec, Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland are considering a regional grid.

2. Quebec and Ontario have started a major study of increased interconnection capacity between Quebec and Ontario.

13.16 Summary

Interconnections have many potential advantages, which fall mainly in the areas of increased system reliability and reduced operating costs. These include the possibility of purchase of power during emergencies, prevention of widespread system outages upon the occurrence of major contingencies, cost savings in day-to-day operation, and the possibility of profitable power sales or purchases. In Ontario Hydro's view, these advantages outweigh the disadvantages.

Ontario Hydro proposes to continue use of interconnections, to study the need to expand interconnection capacity, and to profit where possible from available firm purchases and from co-ordinated development with other systems in Canada and the United States.

In recent years Ontario Hydro has selected its generation reserve requirements by using a 1 in 2400 Loss-of-Load Probability, (LOLP) which takes no account of possible assistance from interconnections. The interconnections do exist however and have been counted upon to provide assistance in the event of major contingencies not accounted for in the LOLP computation.

One potential advantage of interconnections is the possibility of reducing generating reserves in Ontario by increased reliance on assistance from other systems. This would make Ontario Hydro more dependent on other utilities for maintaining reliability and in fact would reduce existing levels of reliability. Ontario Hydro believes this is not a prudent action at the present time because it believes that, in the next five to ten year period, utilities in adjacent areas will have inadequate reserves (Reference 2). Furthermore, in the case of the United States utilities, if the United States generation or fuel shortage reaches the state of national emergency, the U.S. federal government may prohibit or restrict the export of electricity to Canada.

However, it is possible that because of the shortage of capital funds Ontario Hydro will have to increase its reliance on interconnections in spite of the attendant risks.

REFERENCES

1. Ontario Hydro International and Interprovincial Interconnection Agreements January 1975.

2. "Review of Overall Reliability and Adequacy of the North American Bulk Power Systems (Fifth Annual Review)" National Electric Reliability Council, July, 1975.